

DIGITAL ELECTROCHROMIC CIRCUIT WITH A VEHICLE NETWORK

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from United States provisional patent application Ser. No. 60/196,577, filed on Mar. 31, 2000, the disclosure of which is hereby incorporated herein
5 by reference in its entirety.

BACKGROUND OF THE INVENTION

This invention relates generally to vehicle rearview mirror systems and, more particularly, to digital electrochromic rearview mirror systems.

Digital electrochromic mirror systems are described in commonly assigned U.S. Pat.
10 6,089,721 entitled DIGITAL ELECTROCHROMIC MIRROR SYSTEM and U.S. Pat. 6,056,410 entitled DIGITAL ELECTROCHROMIC MIRROR SYSTEM, the disclosures of which are hereby incorporated herein by reference. Such systems are capable of controlling the reflectance level of an electrochromic element from the output of a microcomputer.

Various forms of vehicle communication systems have been developed including
15 wired networks, or busses, operating one of several known protocols. These include a LIN (Local Interconnect Network), a LAN (Local Area Network), a CAN (Car or Controlled Area Network), and the like. An advantage of such vehicle networks is that the wire harness to the mirror can be minimized to as few as three wires or so, yet provide a variety of functions. Wireless communication networks utilizing radio frequency and/or infrared communication
20 for vehicles have also been proposed, such as those utilizing the BLUETOOTH protocol. Such wireless communication and the BLUETOOTH protocol are described in more detail in commonly assigned U.S. patent application Ser. No. 09/793,002, filed Feb. 26, 2001, entitled VIDEO MIRROR SYSTEMS INCORPORATING AN ACCESSORY MODULE, the disclosure of which is hereby incorporated herein by reference.

25 Trainable garage door openers, such as a universal garage door opener available from Johnson Controls/Prince Corporation, Holland, Michigan under the trade name HOMELINK™, include a transmitter for a universal home access system, which replaces the switch in a household garage door opener that opens/closes the garage door. A garage door opener communicating with a smart switch that is programmable to a household specific code
30 that is of the rolling code type, such as is available from TRW Automotive, Farmington Hills, Michigan under the trade name KWIKLINK™, is known to be mounted within vehicles. As described in commonly assigned U.S. Pat. 6,172,613 B1, the disclosure of which is hereby incorporated herein by reference, the universal garage door opener HOMELINK™ unit or the

universal home access KWIKLINK™ unit may be mounted at, within, or on an interior rearview mirror assembly. The KWIKLINK™ system is a low-current device that can, optionally, be operated off of a battery source, such as a long-life lithium battery. It is also compact and lightweight as executed on a single- or double-sided printed circuit board.

SUMMARY OF THE INVENTION

The present invention provides a new and unique combination of a digital electrochromic mirror system, a vehicle accessory and a vehicle network, and, more particularly, a combination of a digital electrochromic mirror system, a garage door opener and a vehicle network. According to an aspect of the invention, a vehicular rearview mirror system includes a digital electrochromic mirror system having a digital drive circuit and an electrochromic reflective element. The reflective element assumes a partial reflectance level in response to a drive signal. The drive circuit provides a drive signal to the reflectance element. The mirror system further includes a garage door opener including a transmitter and a logic circuit. The logic circuit supplies signals to the transmitter for transmitting garage door opening signals. The mirror system further includes a microcontroller which defines, at least in part, the digital drive circuit and the logic circuit. In this manner, the digital electrochromic mirror system has components in common with the garage door opener. According to this aspect of the invention, the microcontroller communicates over a vehicle network with at least a module performing at least one other vehicle function. The vehicle network may have at least wired network connections and may further have wireless connections. The vehicle network may have a protocol selected from the group consisting of a LIN, a CAN, or a LAN.

According to this aspect of the invention, the digital drive circuit and the logic circuit may be mounted on a common circuit board. Power to the digital drive circuit and logic circuit may be supplied from a battery, preferably a rechargeable battery, that is separate from the vehicle ignition. The battery may be charged from a solar power system.

According to another aspect of the invention, a vehicle rearview mirror system includes an interior rearview mirror system made up of an electrochromic reflective element, a housing for the electrochromic reflective element and a circuit board in the housing. The electrochromic reflective element assumes a partial reflectance level in response to a drive signal. A digital electrochromic drive circuit is provided on the circuit board and supplies a drive signal to the reflective element. The mirror system further includes a garage door opener. The garage door opener includes a transmitter and a logic circuit, at least one of which (and preferably, both) is on the circuit board, and share components with, the

electrochromic drive circuit. The logic circuit supplies signals to the transmitter for transmitting garage door opening signals. The garage door opener may, optionally and preferably, also serve as a receiver or a transceiver for a tire pressure status monitoring/display system, such as disclosed in commonly assigned U.S. patent application 5 Ser. No. 09/513,941, filed Feb. 28, 2000, entitled TIRE INFLATION ASSISTANCE MONITORING SYSTEM, and U.S. patent application Ser. No. 09/710,016, filed Nov. 10, 2000, entitled TIRE INFLATION ASSISTANCE MONITORING SYSTEM, the disclosures of which are hereby incorporated herein by reference, and thus have a dual tire pressure monitoring/display and garage door opener function. The mirror system further includes a 10 microcontroller which defines, at least in part, the digital drive circuit and the logic circuit. The digital electrochromic mirror system has components in common with the garage door opener. The microcontroller communicates over a vehicle network with at least one module performing at least one other vehicle function.

These and other objects, advantages and features of this invention will become 15 apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top plan view of a vehicle having a vehicular rearview mirror system, according to the invention;

Fig. 2 is an electronic block diagram of a digital electrochromic mirror system, 20 according to the invention; and

Fig. 3 is an electronic block diagram of a vehicular rearview mirror system, according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, and the illustrative embodiments depicted 25 therein, a vehicular rearview mirror system 10 is illustrated with a vehicle 11 and includes an interior rearview mirror assembly 16 and one or more exterior rearview mirror assemblies, such as driver side exterior rearview mirror assembly 12 and/or passenger side exterior rearview mirror assembly 14 (Fig. 1). Interior rearview mirror assembly 16 includes a digital electrochromic mirror system 18 which is preferably supplied according to the principles 30 disclosed in commonly assigned U.S. Pats. 6,089,721 and 6,056,410, the disclosures of which are hereby incorporated herein by reference. Although the particulars of the invention are illustrated with an interior rearview mirror assembly 16, it should be understood that the principles of the invention could be equally applied to either or both exterior rearview mirror assemblies 12, 14.

Digital electrochromic mirror system 18 includes a microcontroller 20 and an electrochromic mirror reflective element 22. As is disclosed in the '721 and '410 patents, microcontroller 20 receives inputs from light sensors 24 (preferably phototransistors or photodiodes) and supplies digital outputs 26a, 26b which control solid-state switches 28a, 28b in order to provide a drive signal at 30 thereby establishing a partial reflectance level of electrochromic reflective element 22. Microcontroller 20 includes a microprocessor.

Digital electrochromic mirror system 18 further includes a bus interface 32 which interfaces with a vehicle network, or bus, 34. Items on network 34 can be connected by wired or wireless connection. Wired connection may include wire, cables, fiber-optic cables, and the like. Wireless connection can be by infrared (IR) or radio-frequency (RF) communication, and, preferably, may be a short-range RF interconnection using the BLUETOOTH protocol. Vehicle network, or bus, 34 may utilize various buss protocols including a Local Internet Network (LIN), a Local Area Network (LAN), a Car (a/k/a Controlled) Area Network (CAN), or other vehicle network protocol. The BLUETOOTH protocol is a low-cost, low-power radio-based cable replacement or wireless link based on short-range radio-based technology. BLUETOOTH enables creation of a short-range (typically 30 feet or so, although longer and shorter ranges are possible), wireless personal area network via small radio transmitters built into various devices. For example, transmission can be on a 2.45 gigahertz band, moving data at about 721 kilobits per second, or faster. In the illustrated embodiment, network 34 is a multi-drop bus which requires three or fewer wires for communication between a plurality of other vehicle functions 36, as illustrated in Fig. 3. In situations where timing and power consumption system constraints may cause network 34 wakeup time to be too slow for an automobile maker system response requirement, suitable adjustments may be made in the architecture of network 34. The network may be configured as disclosed in commonly assigned U.S. patent application Ser. No. 09/341,450 filed July 8, 1999, by Drummond et al. for a VEHICLE REARVIEW MIRROR AND A VEHICLE CONTROL SYSTEM INCORPORATING SUCH MIRROR, the disclosure of which is hereby incorporated herein by reference.

Other vehicle functions 36 include, by way of example, a seatbelt warning status 38, which status may be displayed on a mirror-based display 40. Preferably, mirror-based display 40 may be located on, at or adjacent interior rearview mirror assembly 16. Mirror-based display 40 may be of various forms including that disclosed in commonly assigned U.S. patent application Ser. No. 09/799,414, filed on Mar. 5, 2001, by McCarthy et al., entitled COMPLETE MIRROR-BASED GLOBAL-POSITIONING SYSTEM (GPS)

NAVIGATION SOLUTION, the disclosure of which is hereby incorporated herein by reference. Additionally, display 40 may display magnetic vehicle heading information from a magnetic sensor 42, the information being supplied over network 34. Additionally, reverse gear status from a reverse gear sensor 44 may be supplied over network 34 to cause digital
5 electrochromic mirror 18 to assume a high reflectance level when vehicle 11 is placed in reverse gear. Rearview mirror system 10 may additionally receive engine information 46 and/or door opener information at 48 over network 34 and activate general lighting 50 located in, at or on interior rearview mirror assembly 16, such as when a door of vehicle 11 is opened. Status from an alarm assembly 52 may also be conveyed over network 34 and
10 displayed by display 40.

Dim ratios, or partial reflectance levels developed from light sensors 24, can be transmitted over network 34 for use to drive exterior mirrors 12, 14. Optionally, a dim ratio or partial reflectance level chosen for a driver-side exterior mirror may be different from (and typically greater than) a dim ratio or partial reflectance level chosen for a passenger-side
15 exterior mirror, and both may be different from a dim ratio or partial reflectance level chosen for a interior electrochromic mirror. Ambient light information, sensed by an ambient light sensor 57, can also be transmitted over network 34 for use in dimming of instrument panel 54 or automatic headlight functions 56. Alternatively, ambient light information can be developed by interior rearview mirror assembly 16 as disclosed in commonly assigned U.S.
20 Pat. 5,715,093, the disclosure of which is hereby incorporated herein by reference.

The interior rearview mirror assembly includes microcontroller 20 and a printed circuit board 61, that are common to both the digital electrochromic mirror system 18 and garage door opener function 66. Sharing of components and circuit board space can facilitate a reduction of susceptibility to RF/EMI interference and reduce cost and avoid duplication of
25 both the network interface hardware 32, communication software and some processing power. The interior rearview mirror assembly may also include a video display system, such as disclosed in commonly assigned U.S. patent application Ser. No. 09/793,002, filed Feb. 26, 2001, entitled VIDEO MIRROR SYSTEM INCORPORATING AN ACCESSORY MODULE, the disclosure of which is hereby incorporated herein by reference. Components
30 may be shared between the video display system, the digital electrochromic mirror system and/or the garage door opener. Additionally, microcontroller 20 may control a forward-facing camera system and headlight control which may also share components with the digital electrochromic mirror system and/or the garage door opener. Such forward-facing camera system and headlight control may be of the type disclosed in commonly assigned U.S.

Pat. 5,796,094 entitled VEHICLE HEADLIGHT CONTROL USING IMAGING SENSOR,
the disclosure of which is hereby incorporated herein by reference. An imaging sensor based
rain sensor of the type disclosed in commonly assigned U.S. patent application Ser. No.
09/530,306, filed Apr. 27, 2000, entitled RAIN SENSOR WITH FOG DISCRIMINATION,
5 may also be incorporated in circuit board 61 and share components with the digital
electrochromic mirror system and/or the garage door opener.

With microcomputer 20 driving digital electrochromic mirror system 18, and with
vehicle status information available over network 34, it is possible to have a circuit assembly
61 in or at interior rearview mirror assembly 16 that is powered by a battery 62 that is
10 separate from the vehicle ignition storage battery. As an example, battery 62 may be of a
long-life lithium type battery. Moreover, because of its relatively small size, battery 62 may
be recharged by a separate dedicated solar-powered rechargeable battery source 64 of the
type described in commonly assigned patent application Ser. No. 09/793,002, filed Feb. 26,
2001, entitled VIDEO MIRROR SYSTEMS INCORPORATING AN ACCESSORY
15 MODULE, the disclosure of which is hereby incorporated herein by reference. By powering
mirror system 10 by a separate-dedicated solar-powered rechargeable battery source, mirror
system 10 can consume power from its dedicated/local battery source, and any power used up
during nighttime hours can be replenished by day via solar cell/panel that is a part of battery
charger 64 and is connected to the dedicated battery 62 so as to recharge/charge during
20 daytime hours. Furthermore, microcomputer 20 can be put into various power-saving modes
thereby enabling electronic assembly 61 to be used for control of a garage door opener 66,
such as a HOMELINK™ unit or the universal home access KWIKLINK™ unit.

Also, a mirror-mounted microphone/digital sound-processing system 68, as disclosed
in commonly assigned patent application Ser. No. 09/466,010, filed by DeLine et al., on
25 Dec. 17, 1999, for an INTERIOR REARVIEW MIRROR SOUND-PROCESSING
SYSTEM, the disclosure of which is hereby incorporated herein by reference, may be also
powered by battery 62. Preferably, sound-processing system 68 is incorporated in circuit
assembly 61 and, most preferably, shows microcontroller 20 with garage door opener 66 and
digital electrochromic mirror 18. Communication button press information 58 can be
30 transmitted over network 34 for various uses by other electronic control units, such as
activation of a rescue system 60, such as General Motors' ONSTAR™ system, a Ford Motor
Company's RESCU™ system, or the like. Use of digital signal-processing and a single
mirror-mounted microphone (such as is described in U.S. patent application Ser. No.
09/396,179, filed Sep. 14, 1999, entitled INDICATOR FOR VEHICLE ACCESSORY, the

disclosure of which is incorporated by reference herein) is particularly advantageous for economical achievement of clear and error-free transmission from the vehicle, while operating along a highway, to a remote receiver, particularly in speech-recognition mode. This use of network 34 facilitates location of button 58 in interior mirror assembly 16.

5 Microcomputer 20 may receive memory information 70 over network 34 and actuate an actuator 72 to position reflective element 24. Principles, disclosed in commonly assigned U.S. Pat. 5,796,176 entitled MEMORY MIRROR SYSTEM FOR VEHICLES, the disclosure of which is hereby incorporated herein by reference, may be utilized for communicating such memory information over network 34.

10 Microcomputer 20 may also use network 34 to measure values of light sensed by light sensors 24, supply drive signals to the electrochromic reflective element, and the like, on the network 34. Partial reflectance levels may be communicated to exterior rearview mirror assemblies 12, 24 over network 34. In this manner, if the interior digital electrochromic mirror system 18 develops a fault, incorrect information will not be transmitted to exterior
15 rearview mirror systems. This also allows exterior reflective elements to have different peak voltages and provides more precise control over each of the mirror assemblies 12, 14, 16.

 Other functions may be controlled over network 34 such as remote keyless entry 74 and global positioning system information/navigational system as described in commonly assigned co-pending application Ser. No. 09/799,414, filed on Mar. 5, 2001, by McCarthy et
20 al., entitled COMPLETE MIRROR-BASED GLOBAL-POSITIONING SYSTEM (GPS) NAVIGATION SOLUTION, the disclosure of which is hereby incorporated herein by reference.

 In addition to placement at, on or in exterior rearview mirror assembly 18, circuit board 61 may be positioned at a location (and preferably in a housing) separate from interior
25 mirror assemblies, such as disclosed in commonly assigned U.S. Pat. 6,099,131 entitled ELECTRO-OPTIC MIRROR SYSTEM, the disclosure of which is hereby incorporated herein by reference.

 Also, the concepts of the present invention provides a new and unique combination of a digital electrochromic mirror system, a vehicle accessory and a vehicle network when the
30 vehicle accessory comprises a tire pressure monitoring/display system.

 Changes and modifications in the specifically described embodiments can be carried out without departing from the principles of the invention which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law including the doctrine of equivalents.